

artificial; aiming at training the pure reason they have got out of touch with facts, and for many pupils degenerated into mere jugglery with symbols cast loose from thought; hence they fail to interest and influence all but a very few. Look at the questions set in any of the well-known examinations—and see how many of them consist of stock puzzles of more or less complexity, invented, apparently, solely in order that successive generations of boys may learn how to deal with them, score marks by them, and then lay them aside as useless! And, of course, a large portion of our text-books and our teaching is necessarily devoted to such questions. So long as the chief examinations maintain their present character a general reform of school mathematics is well-nigh impossible, and partial reforms at individual schools (I have Winchester in mind as a pioneer in endeavour) are very difficult. I will, however, briefly and without detail indicate directions in which I think real improvement can be made without introducing revolutionary changes.

The great aim must be to introduce as much as possible the concrete element, for there are few boys who cannot be interested keenly in what they can deal with in practical fashion by drawing or handling in any other way, and fewer still to whom a bare abstract idea is not repellent. Until elementary physical measurements and the mathematics appropriate for dealing with them are taught together, an arrangement much to be wished for both from the points of view of science and mathematics, the best field for the introduction of the concrete is undoubtedly geometry.

In all the earlier stages of geometrical work, theory should always be kept in touch with practice by much drawing and measuring of figures; this, I am convinced, is the best way of building up exact geometrical ideas, and it has besides the great advantage of being intensely interesting to boys. I do not refer to "geometrical drawing" as often taught and usually understood in examinations which aims merely at making certain constructions (though this gives a valuable bit of training to those who have too often no notion of using their hands efficiently for any purpose not connected with a ball), but I would have it used always concurrently with, and in illustration of, demonstrative geometry. This is, I know, quite possible, though I have as yet come across no text-book in which it is done.

In theoretical geometry the only serious divergences from Euclid's methods I would advocate are (1) the introduction from the first of the idea of an angle as generated by a rotation, and (2) the substitution of the arithmetical and algebraical treatment of proportion for Euclid's.

Euclid's test of proportion, which appeals so strongly to the grown mathematician by its elegance and completeness, is for even the very best boys very difficult to grasp, and for the moderate boy a rigid insistence on it (which is practically never made) would involve an absolute bar to the discussion of similar figures and elementary trigonometry, matters which are quite easy if the difficulty of incommensurability be kept in the background. I would, however, while adhering to Euclid as the only possible text-book, omit, on a first reading at least, many of the propositions in order to push on to those which connect with, and can be illustrated by, practical work. For instance, after Book I., I would have read those propositions of Book III., some dozen or so in number, proving the angle properties of circles.

Seeing that demonstrative geometry furnishes by far the most accessible example of pure deductive logic, and for most boys the only one they will ever come in contact with, I would insist most strongly on its never being sacrificed to so-called "proofs" by measurement which are found in some books. The training of the reasoning powers is one of the highest aims of education, and with this end in view constant practice in riders is of the greatest value; the teaching of Euclid's text without this is a most deadly waste of time, and cannot be too strongly condemned.

In arithmetic I think the most important reform would be the general recognition of the fact that decimals are not adapted for exact calculation, but are preeminently valuable in approximation, which is the practically useful form.

From the first, therefore, boys should be taught to work out results correct to a few places only—generally not more than four—and all work with recurring decimals should be omitted.

Many of the puzzling questions set on such subjects as discount, stocks, &c., have very slight relation to practical life,

they require much time to learn to deal with them, and should be discarded in favour of work on areas and volumes of simple figures. An equal amount of thought can be elicited, and therefore a not less amount of culture imparted, by good problems on the latter subjects, with the advantage of being more in touch with practical requirements.

In algebra I would, in the earlier stages, insist much more closely than is done at present on the accurate use of symbols as a shorthand language for expressing arithmetical operations, deferring long "sums" of multiplication, division, &c., until much work has been done on simple equations of the first degree as aids to the solution of problems. Later I would omit much of the harder manipulation with fractions and abnormal index expressions which is now taught, and in place of these devote much time to the development of the notion of one quantity as a function of another, illustrated by plotting graphs on squared paper. The theory of fractional and negative indices should be taught as leading up to logarithms to base 10, but I deprecate the too early use of these in calculation.

Arithmetical trigonometry involving functions of acute angles only, and with constant reference to four-figure tables and accurate drawings to scale, should be taught much more generally than it is now. For boys in the higher forms who are but poor mathematicians I have found it an interesting and stimulating change from the weary round of arithmetic and algebra they had trodden *ad nauseam* before. A short course of the same work should, even in the case of good boys, be preliminary to the algebraical treatment of trigonometry.

I have written only of the very lowest rungs of the mathematical ladder; those who from professorial and engineering altitudes lecture us on what we ought to teach have often no notion of the mind stratum in which the greater part of our life's labour is spent; hence their advice, and their books when they condescend to write for us, are too often hopelessly above the mark. That by cooperation of all interested some real improvements in the curriculum may enable us to get a rung or two higher all round is the earnest wish of myself and many other teachers.

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The Distance of Nova Persei.

SINCE publishing, in NATURE of January 2, the suggestion that the cause of the apparent expansion of the nebula surrounding Nova Persei might be explained by the illumination of meteoric matter by the light sent out on the occasion of the outburst of the Nova, I have seen a paper published by Prof. Kapteyn in the *Astr. Nach.* (No. 3756), in which he suggests the same idea. His claim to priority in the matter is therefore clear. In my note, referred to, I give the distance of the Nova as 313 light years. In calculating this distance I made the mistake of taking the date of the outburst as February 12 instead of the 22nd. This made the distance of the Nova considerably too great.

Let D denote the distance of the Nova, and r the radius of the nebula, in miles; and let ρ be its radius in seconds of arc. Then we have

$$\frac{r}{D} = \frac{\rho}{206265} \therefore D = 206265 \times \frac{r}{\rho} \dots (1)$$

But if V is the velocity of light in miles per second, and if T be the time in days elapsed from the outbreak of the star to the date of the photograph, then

$$r = 24 \times 60 \times 60 \cdot V \cdot T \dots (2)$$

Substituting this in (1) we find

$$D = 24 \times 60 \times 60 \times V \times 206265 \times \frac{T}{\rho} \dots (3)$$

Also if L be the distance travelled over by light in a year of 365½ days, i.e. a light year, then

$$L = 24 \times 60 \times 60 \times V \times 365\frac{1}{2} \dots (4)$$

Dividing (3) by (4) we find

$$\frac{D}{L} = \frac{206265}{365 \cdot 25} \frac{T}{\rho}$$

or

$$D = \left[2 \cdot 75184 \right] \times \frac{T}{\rho} \times L, \dots (5)$$

the figures in brackets being the logarithm of $\frac{206265}{365 \cdot 25}$.

Taking $T=211$ days from the outburst to the date of the photograph taken on September 20 and the angular distance ρ of the point (a) on Ritchey's photograph as equal to $480''$, the distance D is equal to 248 light years. The same point on the photograph of November 13 leads to $D=265$. The difference between these two values of D is, I believe, as Prof. Kapteyn also points out, due to the fact that the plane of the nebula is not normal to the line of sight. Ritchey also points out that, besides the radial expansion, there has been an apparent motion of the nebula round the Nova in position angle. From an examination of the photographs, the nebula seems to be evidently a spiral, and the observed shift in position angle would be caused by the gradual illumination of these spiral wreaths by the advancing spherical wave of light.

It can be shown that, if the sun were removed to the distance of the Nova, it would only be of the $10\cdot24$ magnitude, so that, even at the present moment, the Nova is more brilliant than the sun. When the Nova was at its greatest brilliancy it was about $0\cdot2$ magnitude. It must then have been $10,380$ times brighter than the sun. If we take the light of the Nova at the earth as equal to a first-magnitude star and take Zöllner's estimate of this compared to the sun as $\frac{1}{5 \times 10^{10}}$, then the outer margin of the nebula with a radius of $8'$ would be 430 times nearer the Nova than the earth, and would receive per unit area 430^2 times the amount of light, or $\frac{430^2}{5 \times 10^{10}}$, which is equal

to $\frac{1}{270500}$, of sunlight. This is about equal to $2\cdot2$ times the light

of full moon. Of course, these figures are of very uncertain value and we must not place too much reliance on them, but if we take the above value of $2\cdot2$ times moonlight as that received by the nebula, it at first seems too faint to be visible as reflected light. We must, however, recollect that the light reflected from the nebula at its brightest points cannot have an intrinsic brilliancy of more than an eighteenth-magnitude star, whereas the Nova was of the first magnitude. Hence it is only necessary for the nebula

to reflect light of an intrinsic brilliancy equal to $\frac{1}{6,310,000}$ th

that of the Nova to seem as bright as it actually is, even assuming that the nebula has no inherent light of its own. The above figures will evidently require some alterations when the photographs available are carefully measured. W. E. WILSON.

Daramona, co. Westmeath, Ireland.

A Luminous Centipede.

IN your issue of January 9 (p. 223), an account of some observations of the *Geophilus* is given, from which it would appear that it used its power of emitting light as a means of protection. It might be well to point out that irritation or excitation of many luminous organisms has this result. Even in such low forms as the light-producing bacteria the same effect can be seen. In a paper on the "Physical Basis of Animal Phosphorescence," by S. Watasé, of the University of Chicago, published with the biological lectures delivered at Woods Holl, 1895, a very full account is given of the phenomenon as seen in the ordinary fire-fly, and the process is essentially the same in all light-producing organisms. In some the luminous product of cell metabolism is oxidised *in situ*, while in others it is thrown out in response to a stimulus as a liquid secretion.

J. E. BARNARD.

Birds Capturing Butterflies in Flight.

MR. LATTE still believes the capture of butterflies in flight by birds to be "exceptional so far as this country is concerned" (p. 273). Closer observation would assure him of the contrary, I think. Why is the case he mentions "probably to be regarded as a mistake on the part of the bird," when it is admitted that the captor "only relinquished its hold in consequence of a luckily-aimed stick"? Why assume that the thrower of the stick knew better what the house-martin ought to eat than the bird itself? In July 1900 I saw a house-sparrow in my garden attack a common brown butterfly on the wing (species unidentified). The chase lasted three minutes, by my watch, *in the air* the whole time, the butterfly doubling and turning again and again, and the sparrow after it, in a manner most remarkable for a bird without much hovering-power.

Eventually both butterfly and sparrow went into a box hedge, and the sparrow came out immediately afterwards, eating the butterfly; he finished it with much apparent satisfaction on a branch of an apple-tree, and cleaned the scales off his beak on the twig. Sparrows are not, as a rule, insect-eaters, but J. H. Gurney gives, as a result of 694 dissections, under the heading "occasional food," these entries:—

"August.—Moth of *Crambus culmellus*."

"June.—Large brown cabbage-moth (W. Johns)," and adds: "I have notes of sparrows occasionally feeding on the yellow Underwing, Ermine moth, and a few other insects in the perfect state. . . . Everybody must, at some time or another, have observed their clumsy efforts to catch some common butterfly" ("The House-sparrow," Gurney, Russell and Coues, pp. 11–18). These notes have the greater value because they occur in a book written with the avowed object of convicting the sparrows of a diet injurious to the agriculturist!

If, therefore, attacks by "occasional" enemies are not infrequent, why imply that the toll taken by the vast crowd of insectivorous birds "*must be very slight*?" The question is, is it? Only specially directed observations can answer this.

LILIAN J. VELEY.

20 Bradmore Road, Oxford, January 26.

Extremes of Climate in the British Empire.

I HAVE just read the note on p. 87 of your issue of November 28 last giving an abstract of the "Summary of the Climate of the British Empire" in *Symons' Meteorological Magazine*; and I think that even though it is expressly said to be only "so far as it can be represented by reports for eighteen stations," such a summary is misleading. Thus, Adelaide is given as having the highest shade temperature, absolutely ignoring the fact that Lahore, with a population 50 per cent. more than Adelaide, has a maximum shade temperature for a month or more at a time rarely falling below 116° , and often well over 120° ; while in Jacobabad, a much less important place, it is true, but still a garrison town, the maximum shade temperature in June and July is more often over 120° than under it.

Again, for maximum rainfall, not to mention Cherra Punji, with an average of more than 400 inches, or many places on the west coast of India and Burmah with averages of 100 to 200 inches, the large town of Rangoon is far wetter than Calcutta. Being far from records here I can only give averages; but I do not think I am wrong when I say that the places mentioned in your paragraph are hardly typical of the extremes of climate exhibited by even the larger places in the British Empire, which, I take it, should be the object of such a summary.

Lalitpur, India, January 2.

CHAS. A. SILBERRAD.

A GALLERY OF ANIMAL ENGRAVINGS OF THE STONE AGE.

THE clever etchings on bone and ivory of the cave-dwellers of western Europe who lived towards the close of the Palæolithic period are well known to all who interest themselves in the pre-history of man. In 1895 M. E. Rivière published the first discovery of engravings and pictographs on the sides of a cavern. The second and quite recent similar record is published in the *Comptes rendus* of the Paris Academy of Sciences (December 9, 1901, p. 1038) by MM. Capitan and Breuil. These archaeologists had the good fortune to discover on the walls of the cave of Combarelles, in the neighbourhood of Eyzies (Dordogne), 109 engraved figures which date from the Magdalenian epoch. All the figures are engraved upon the vertical walls of the cave for a distance of 100 metres on each side of the passage. They reach to an average height of 1·50 metres, commencing at about 15 or 20 centimetres above the ground and often extending to the roof—which, in truth, is mostly low, being only one to two metres in height, but this has been curtailed by stalagmites.

The figures are mostly deeply graven in the rock, but some designs are merely scratched. Very often they have been coated by a layer of stalagmite which is